twenty years has in so astonishing a measure verified the prophecy of the "Origin of Species," surely, in conclusion, we are more than ever constrained to agree with the sentiments expressed by its closing words :—"When I view all beings, not as special creations, but as the lineal descendants of some few beings which lived long before the first bed of the Cambrian system was deposited, they seem to me to become ennobled. . . . There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one ; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved."

(*To be continued.*)

ECLIPSE NOTES [1]

III.

THE eclipse of 1882 is now over, and it is not too much to say that the observations have been most successful. Much more work has apparently been done in former eclipses, but it has been of a far more general nature, and, as the old saw has it, *dolus latet in generalibus*. This year the work has put on very much more of a quantitative look, and each observation therefore more or less means a real step in advance. And indeed the time had come when this should be so, for day by day the quantity of laboratory work done which can be more or less compared with eclipse observations is increasing, and in the case of general observations either in one case or the other comparisons are impossible. I have taken many prior occasions of insisting upon this point; but perhaps the reason why this principle has been so generally acted upon on the present occasion has been a capital example set to future eclipse parties. Some days before the eclipse there was a regular Congress of the leaders of the different expeditions and the chief observers, held under the presidency of Mahmoud Pacha, the astronomer at Cairo, and not only was the general plan of observations agreed upon but the necessity of a limited field of inquiry was generally acknowledged ; hence at the moment of the eclipse each worker had only a limited part of the spectrum to study, and the instrument to be employed whatever its form, and there were many forms employed, was carefully prepared for this part, and this part only, before totality.

In the way of dispersion, MM. Thollon and Trépied outdistanced all their *confrères*, as each had the most powerful form of Thollon spectroscope yet constructed. The dispersion in this instrument is about the same as that given by a Rutherfurd grating (of 17,000 lines to the inch) in the third order, with this important difference, that the quantity of light is much greater, so that a spectrum can be much better observed. With these spectroscopes, object-glasses of 9 inches aperture, and siderostats of a simple altazimuth focus were employed. All the other spectroscopic arrangements, whether for eye or photography, were mounted on equatorial stands. The instruments employed for exposing the rapid plates, which recent progress in photographic science has placed in the hands of the astronomers, were perhaps the most complicated Thus we had a camera with large lens some 5 feet focus ; on this a slitless spectroscope of the Fraunhofer form, similar to that employed in Siam in 1875, but with a prism of greater angle in front of the object-glass then a tele-spectroscopic camera of small dispersion with small image of the sun in the slit, and last of all an ordinary camera of small focus.

Perhaps before I go further it will be convenient to give a collective note agreed upon in a second congress held two hours after the eclipse. This will show the *general* opinion as to the general results.

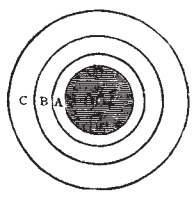
"Unprecedented facilities afforded by Egyptian Government for observation of the eclipse. The plan carried out was agreed upon by the members of the English, French, and Italian expeditions. The accord among the results is very satisfactory. Photographs of the corona and of its complete spectrum were obtained by Schuster on Abney's plates, H and K being the most intense lines. A study of the red end of the spectrum of the corona and prominences was made by Tacchini. A comet which was very near the sun, and a very striking object, was photographed and observed with the naked eye. Bright lines were observed before and after totality of different heights by Lockyer, and with intensities differing from the Fraunhofer lines by Lockyer and Trépied. An absolute determination of the place of the coronal line at 1474, of Kirchhoff's scale, was made by Thollon and Trépied. The absence of dark lines in the corona spectrum was noted by Tacchini and Thollon with very different dispersions. Many bright lines in the violet were observed in the spectrum of corona by Thollon, and were photographed by Schuster. Hydrogen and coronal lines studied in grating spectroscope by Puiseux, and in direct-vision prism by Thollon. Rings observed with grating by Lockyer, first, second and third orders. Continuous spectrum relatively fainter than in 1878, and stronger than in 1871. Intensification of absorption observed in group A at the edge of the moon by Trépied and Thollon.

"LOCKYER, TACCHINI, THOLLON."

Having given the collective note, I may be permitted to refer first to those observations which specially bear upon the matter dwelt upon in these notes—observations touching the bright lines seen before and at the moment of totality.

The importance of this part of the work arises from the following considerations :—If there be a layer of a certain height, by the absorption of which the lines of Fraunhofer are reversed, the lines visible under the stated conditions during eclipses will all be of the same height, and their intensities will all be those of the Fraunhofer lines; if, on the contrary, the reversing layer is a myth, as I believe it to be from a consideration of all the prominence and spot work done up to the present time, the lines will not be all of the same height, and the intensities will widely differ from those of the general spectrum of the sun, for the following reasons :—

As explained in my first batch of notes, it is most probable that the solar spectrum is built up of the absorption of different layers, and not of one, thus—



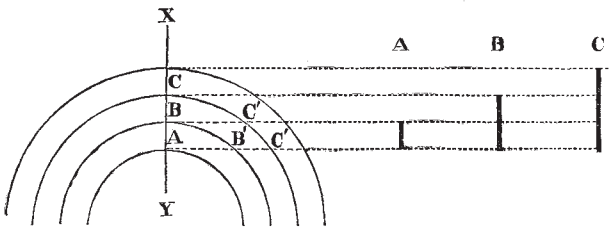
A, B, C, layers.

A, layer nearest the sun, and therefore hottest, and

[1] Continued from p. 52.

therefore probably best represented in prominence-spectrum. B and C, layers further from the sun, and therefore cooler, and therefore probably best represented in spot-spectrum.

If this be so, when we can see the lines of these layers we shall see something like this—



The lines of A—the hottest layer—will be brightest and shortest.

The lines of B—the next cooler layer—will be less bright and longer, and will also go down to the sun, on account of the part of the layer at B, although it is unrepresented at A, along the section X—Y.

And so on with C.

In an eclipse we have a condition in which the atmospheric light is gradually withdrawn. The lines should appear, therefore, in the order of their lengths ; that is, the line which turns out to be longest should be the last to appear, and this is a magnificent proof that the substance which produces the line does not extend down to the sun, for if it did it should be brightest at bottom, and should at first appear as a short line.

Now what were the facts? Dealing with the region between F and *b*, and not all of that, and especially with the three iron lines I have so often mentioned, this was the order of appearance—

May 17, 8.18 a.m., saw F and T_1 very short.

(T_1 meaning the single iron line of the three *w l* 49233 so constantly seen by Tacchini in prominences).

8.19 ... F + T_1 + 4933 short.
8.20 ... F + T_1 + 4933 + *b* long.
8.23 ... F + T_1 + 4933 + *b* + T_2 short.

(T_2 meaning a high temperature iron line at *w l* 50176, constantly seen by Tacchini with 49233).

At this time the darkness sensibly decreased, and then for the first time several long thin lines suddenly burst out.

8.23.30 : Single iron line at 49565, and double at 4918 and 49195 and line at 49325, the last three being the longest. Other long lines made their appearance, but their positions were not absolutely determined.

Totality was announced at 8h. 25m. 42s., and it was arranged that I should then change my instrument. I fancy the signal was given a little too soon, for when I went to my $3\frac{3}{4}$ telescope to study the structure of the corona the cross wires were still some distance from the point at which the sun disappeared ; but be this as it may, I missed the flash, but this was unimportant, the real work was done. Still this is a point so crucial that we ought not to be satisfied till all these changes, even in luding the flash, have been photographed on a moving photographic plate, an idea which struck me too late for utilisation during the present eclipse.

Next, as to the structure of the corona. Again the predictions were fulfilled ; we were in presence of a repetition of the eclipse of 1871 ; everything special to that of 1878 had disappeared. There was absolutely no structure near either pole. I was using the same telescope as in 1878, when this feature was so marked, so there can be no mistake on this point. The filamentous character of the streamers, a marked feature in 1871, was however not so decided.

As with the structure so with the ring spectrum. The rings so bright in 1871, so conspicuously absent in 1878, were again visible, but with a Rutherfurd grating they were not so obvious as I at all events expected to find them. As seen at mid-eclipse, 1474 was the faintest ring, and C the brightest.

With regard to the spectrum of the corona as seen with an ordinary tele-spectroscope, arranged to give as much light as possible, I have not so much to say as I had hoped, for the reason that the totality lasted longer than we counted upon. The result of all the preliminary *pourparlers* had been to fix upon sixty-five seconds as the most probable duration of totality, or rather as the duration to be provided for especially from the photographic point of view, since a photograph exposed during totality would be ruined if the sun reappeared before the cap of the camera had been replaced. Sixty-five seconds having elapsed from the announced commencement of totality, I went to the corona spectroscope which I should have gone to ten seconds earlier (but the comet had taken five seconds, and the grating observation had been more uncertain than I had expected). At the moment I made the observation the eclipse was over, but still I noted F, and 1474, and C, bright, and extending right across the field, and a *banded spectrum*, that is to say, not a continuous spectrum certainly, but into maxima and minima, though the minima gave no signs of dark lines. The observation, however, was almost instantaneous, and too much importance must not be attached to it.

Here my notes must close for the present ; 104° in the shade is not conducive to writing, even if camels were not growling, and flies teasing, as they can tease in Egypt.

J. NORMAN LOCKYER

Siout, May 21

(*To be continued.*)

BIOLOGY AND AGRICULTURE

RECENT advances in our knowledge of the lowest forms of life have tended to bring into prominence not only their relation to disease but to the ever-increasing importance of the part which they play in our arts and industries. Probably in none of the industrial arts, save those concerned with fermentation, commonly so called, has the progress of this branch of biology shown such remarkable development as in its bearing on the art of agriculture.

It has even been suggested that a *bacterium* is at the bottom of the present state of agricultural depression, and there is a considerable amount of force in this suggestion. The loss of nitrogen from the soil in the form of nitrate is one of the most serious difficulties with which the farmer has to contend ; and, as this loss takes place by the washing out of nitrates in the drainage and its diffusion into the subsoil below the reach of the